MMSys´16

Proceedings of the 7th International Conference on Multimedia Systems (MMSys´16)

Association for Computing Machinery

Advancing Computing as a Science & Profession

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Welcome to the Proceedings of the 7th ACM Multimedia Systems Conference (MMSys'16)

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Foreword

It is our pleasure to welcome you to ACM MMSys 2016, the 7th International Conference on Multimedia Systems, in Klagenfurt am Wörthersee, Austria.

The ACM Multimedia Systems Conference (MMSys) provides a forum for researchers to present and share their latest research findings in multimedia systems. While research about specific aspects of multimedia systems are regularly published in the various proceedings and transactions of the networking, operating system, real-time system, and database communities, MMSys aims to cut across these domains in the context of multimedia data types. This provides a unique opportunity to view the intersections and the inter-play of the various approaches and solutions developed across these domains to deal with multimedia data types.

An important and unique aspect of MMSys is that we encourage the use of common datasets for experimentation leading to reproducible research. The **dataset track** provides an opportunity for researchers and practitioners to make their work available and citable. Authors publishing datasets will benefit by increasing the public awareness of their effort in collecting the datasets. Additionally, MMSys provides researchers, engineers, and scientist to present the opportunity to showcase their research prototypes, systems, and applications to MMSys attendees. Therefore, the **demo session** is intended as real, practical, and interactive proof of the presenters' research ideas and scientific or engineering contributions, with the goal of providing multimedia researchers and practitioners with the opportunity to discuss working multimedia systems, applications, prototypes, or proof-of-concepts.

This year's edition of MMSys features two **special sessions**, one on **augmented reality** and one on **media synchronization**. The former deals especially with systems issues and integration of technologies, and often involves innovative system design as well the development of novel system components. The latter addresses latest advances and remaining challenges on media synchronization to accommodate emerging forms of immersive, personalized and ultra-realistic media experiences in our multi-sensory, multi-protocol and multi-device world.

We have made great efforts to compile a strong technical program. ACM MMSys'16 includes 20 accepted full papers (out of 71 submissions; 28% acceptance rate), provides three exciting keynotes, and five overview talks by renowned experts:

Keynotes

- "Ten Thousand Channels to Ten Million Viewers: Technologies for Scaling Video Delivery over IP" by Neill A. Kipp, Comcast VIPER, USA
- "Advances and Trends in Augmented Reality Systems" by Dieter Schmalstieg, Graz University of Technology, Austria,
- "5G enabling the Tactile Internet" by Frank Fitzek, Technische Universität Dresden, Germany

Overview Talks

- "Using Games to solve Challenging Multimedia Problems" by Oge Marques, ACM Distinguished Speaker, FAU, USA
- "More Juice Less Bits: MediaMelon Content Aware Streaming" by Ali C. Begen, MediaMelon Inc., USA, Ozyegin University, Turkey, IEEE ComSoc Distinguished Lecturer
- "MPEG-DASH Spatial Relationship Description" by Omar Aziz Niamut, TNO, The Netherlands
- "Mulsemedia: Novelty or Reinvention?" by Gheorghita Ghinea, Brunel University, UK
- "Smart Camera Systems" by Bernhard Rinner, Alpen-Adria-Universität Klagenfurt, Austria

MMSys'16 is co-located with three workshops, namely the 8th International Workshop on **Massively Multiuser Virtual Environments** (MMVE'16), the 8th International Workshop on **Mobile Video** (MoVid'16), and the 26th International Workshop on **Network and Operating Systems Support for Digital Audio and Video** (NOSSDAV'16).

As MMSys'16 chairs, we would like to thank everyone who contributed to the technical and organizational success of the conference: the authors, the invited speakers, the technical program committee members and all reviewers, and the members of the organizing committee and the steering committee. The support of the workshop sponsors is also greatly appreciated, namely ACM and SIGMM but also our corporate sponsors Adobe, YouTube, DASH-IF, Comcast VIPER, Alpen-Adria-Universität Klagenfurt, Bitmovin Inc., Förderverein Technische Fakultät, FXPAL, and Qualcomm Inc. Thank you very much.

We sincerely hope that the carefully crafted technical program, the social events, the scientific discussions, and your other activities in Klagenfurt and its surroundings, most importantly the lovely Lake Wörthersee, will make your ACM MMSys'16 participation worthwhile and a memorable experience.

Christian Timmerer, MMSys'16 General Chair, Alpen-Adria-Universität Klagenfurt and Bitmovin Inc., Austria

Ali C. Begen, MMSys'16 Technical Program Committee Chair, MediaMelon Inc., USA, Ozyegin University, Turkey

Dataset Track

The dataset track is an integral part of the MMSys conference since 2012. This established platform creates an opportunity for researchers and practitioners to make their work available to the multimedia community and citable. The published datasets throughout the years enabled the community with up-to-date and powerful tool for experimentation leading to reproducible research. Authors publishing datasets benefit by increasing the public awareness of their effort in collecting the datasets. Submissions to the dataset track are diverse and cover broad range of topics as nearly all areas of multimedia research are in need for good datasets to build their evaluations upon.

This year there were 16 submissions, from which 10 were selected for publication and presentation at MMSys'16. All submissions were peer-reviewed by at least three members of the technical program committee. Datasets were evaluated on the basis of the collection methodology and the value of the dataset as a resource for the research community, with focus on the quality, timeliness, novelty and availability of the dataset.

Media types of the presented datasets range from mobile bandwidth traces, through still images, light field images to UHD video. The content is annotated with additional information, e.g. eye tracking, geo tags or other data obtained usually via assessment by human annotators. The area of intended use is also broad, e.g. testing of game-specific visual attention models, testing of systems with location information, network behavior prediction, development of recommender systems, evaluation of techniques in social media retrieval, action recognition, social event detection, study of dynamic visual attention, testing of light field image processing. I believe that the datasets selected for MMSys'16 dataset track will be used broadly by the community.

I would like to thank all the authors who submitted their work to the dataset track, not only for contributing to the conference, but also for sharing their data and taking the extra effort to prepare it and make it accessible for other researchers. Thanks go to all the technical program committee members for providing high quality reviews. Special thanks go also to Prashant Shenoy for hosting all the datasets since 2013 at:

http://traces.cs.umass.edu/index.php/Mmsys/Mmsys

Karel Fliegel, Czech Technical University in Prague, Czech Republic

MMSys'16 Dataset Track Chair

Demo Session

With the MMSys demo session, researchers, engineers, and scientist are provided with the opportunity to showcase their research prototypes, systems, and applications to MMSys attendees. Demos are intended as real, practical, and interactive proof of the presenters' research ideas and scientific or engineering contributions, with the goal of providing multimedia researchers and practitioners with the opportunity to discuss working multimedia systems, applications, prototypes, or proof-of-concepts. Such a setting allows conference attendees to view and interact first hand with live evidence of innovative solutions and ideas in the field of multimedia and to see leading edge research at work. This year we received 19 submissions, from which 16 were selected for demonstration at MMSys'16. Demonstrations vary from content delivery to medical applications, from media retrieval to metadata extraction, and from low-delay to ultra high resolution. We would like to thank all the authors who submitted their work to the demo session. We would also like to thank the TPC members for their careful reviews, allowing us to select high-quality demonstrations, that will surely lead to lively discussions at MMSys'16!

Omar Niamut, TNO, The Netherlands

Michael Zink, University of Massachusetts in Amherst, USA

MMSys'16 Demo Session Co-Chairs

Special Session on Augmented Reality

We brought back the Augmented Reality special session for its second year at MMSys. This year will bring rapid advancement in hardware and software of Augmented Reality devices in the consumer and commercial spaces. With this advancement of technology, we felt the continued need for more advanced algorithms and techniques which are key to Augmented Reality's future success. Image stitching, 3D overlays, registration, and streaming video with augmented data are just a few of topics under the umbrella of AR. The intersection of multimedia and augmented reality is upon us, and we hope this special session will foster interaction between the MMSys and augmented reality research communities.

For this special session, we have accepted three papers that cover a range of topics in augmented reality research, including lighting estimation, robust camera calibration in a markerless AR system, and a new way to rehabilitate patients using Exergames in AR. These accepted papers not only represent the breadth of topics which lie at the intersection of multimedia systems and augmented reality research, but also illustrate the welcome participation of both industry and academic researchers from across the globe in this field. We would like to thank the MMSys organizers for giving us the opportunity to organize a session focused on the augmented reality, and the TPC members for their careful reviews. Thank you also to the authors for submitting their exciting work for the session.

Jonathan Ventura, University of Colorado Colorado Springs, USA

Carl S. Marshall, Intel Corporation, USA

MMSys'16 Special Session Co-Chairs

Special Session on Media Synchronization

Media synchronization has been a key research area since the early development of (distributed) multimedia systems. Over the years, solutions to achieve intra- and inter-media synchronization in a variety of applications and scenarios have been proposed. However, it is not by far a solved research problem, as the latest advances in multimedia systems bring new challenges. The coexistence and integration of novel data types (e.g., multi-sensorial media or mulsemedia), advanced encoding techniques, multiple delivery technologies, together with the rise of heterogeneous and ubiquitous connected devices, are resulting in a complex media ecosystem for which evolved, or even new synchronization solutions need to be devised.

The goal of this Special Session has been to address exactly that: latest advances and remaining challenges on media synchronization to accommodate emerging forms of immersive, personalized and ultra-realistic media experiences in our multi-sensory, multi-protocol and multi-device world. The purpose is to provide a forum for researchers to share and discuss recent contributions in this field and to pave the way to the future, by focusing on different aspects of multimedia systems, such as: content types, (multi-)processing techniques, networking issues, adaptive delivery and presentation, and human perception (QoE). This special session is the continuation of the MediaSync Workshop series (2012, 2013 and 2015) and of Special Sessions in other venues (QoMEX 2014).

For this Special Session, we received 6 submissions, each of them being thoroughly reviewed by at least 3 experts. After the review process and internal discussions, 2 papers were selected for publication and presentation at ACM MMSys (33.3% acceptance rate). The two accepted papers cover two key aspects of media synchronization: 1) media synchronization and sequencing in web-based scenarios; and 2) time synchronization in distributed and wireless applications. We believe that these papers provide relevant contributions, which lie at the intersection of multimedia systems and media synchronizations, and can serve to foster interaction and inspire the audience with new ideas.

We would like to thank the technical program committee for helping in shaping the session.

Pablo Cesar, CWI: Centrum Wiskunde & Informatica, The Netherlands

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Mario Montagud, CWI & UPV, The Netherlands/Spain

Alexander Raake, Ilmenau University of Technology, Germany

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Keynotes

Ten Thousand Channels to Ten Million Viewers: Technologies for Scaling Video Delivery over IP

Neill A. Kipp, Comcast VIPER

Abstract: Comcast's Video IP Engineering and Research (VIPER) team is responsible for delivering tens of thousands of IP linear television channels and thousands of hours of on-demand content to tens of millions of users using a highly scalable, multi-tier software and network architecture. Adaptive bitrate (ABR) technologies such as DASH (ISO 23009-1) let us originate and deliver video segments as internet objects that are conveniently retrieved, stored, and forwarded using HTTP. With an ABR platform, we can experiment with encoding technologies such as H.264 (MPEG-4 AVC), H.265 (HEVC), and high dynamic range (HDR). We use multimedia presentation technologies to implement an interactive and compelling user experience to our customers, while our alternate content systems require metadata, signaling, splicing, scaling, and reporting that is an order of magnitude more complex than primary video delivery. Comcast continues to solicit, utilize, and share contributions from open source communities, standards bodies, and especially academic researchers for the technologies that make our IP video system possible.

Biography: Neill A. Kipp is a Distinguished Engineer for Comcast VIPER. Kipp developed VIPER's Super8 packager that serves IP video to Xfinity apps. Kipp was Honorarium Instructor in Computer Science at the University of Colorado Denver where he taught graduate-level courses including Object Design, User Experience Design, and Ubiquitous Computing. No stranger to the podium, Kipp is an charismatic speaker who has engaged audiences at dozens of technical conferences, including ApacheCon, ACM, Java, Seybold, and SCTE.

Advances and Trends in Augmented Reality Systems

Dieter Schmalstieg, Graz University of Technology

Abstract: Augmented Reality is an emerging new medium, with the potential of becoming very important for any kind of mobile computer use. However, creating Augmented Reality applications that go beyond proof of concept is very challenging, as it requires the successful combination of many non-trivial elements: The technology must be real-time, human-in-the-loop, accurate and precise, context-aware, and work outdoors, operated by potentially naive users. The talk will draw examples from 20 years of experience in Augmented Reality research to highlight trends and directions for future real-world systems.

Bio: Dieter Schmalstieg is full professor and head of the Institute for Computer Graphics and Vision at Graz University of Technology, Austria. His current research interests are augmented reality, virtual reality, computer graphics, visualization and human-computer interaction. He received Dipl.-Ing. (1993), Dr. techn. (1997) and Habilitation (2001) degrees from Vienna University of Technology. He is author and co-author of over 300 peer-reviewed scientific publications with over 10,000 citations, with over ten best paper awards and nominations. His organizational roles include associate editor in chief of IEEE Transactions on Visualization and Computer Graphics, member of the editorial advisory board of computers & graphics and of the Springer Virtual Reality journal, member of the steering committee of the IEEE International Symposium on Mixed and Augmented Reality, chair of the EUROGRAPHICS working group on Virtual Environments (1999-2010), key researcher of the K-Plus Competence Center for Virtual Reality and Visualization in Vienna and key researcher of the Know-Center in Graz. In 2002, he received the START career award presented by the Austrian Science Fund. In 2012, he received the IEEE Virtual Reality technical achievement award for seminal contributions to the field of Augmented Reality. He was elected as a senior member of IEEE, as a member of the Austrian Academy of Sciences and as a member of the Academia Europaea. Since 2008, he is also director of the Christian Doppler Laboratory for Handheld Augmented Reality.

5G enabling the Tactile Internet

Frank H. P. Fitzek, Technische Universität Dresden

Abstract: The tactile Internet will enable a global network to control and steer the Internet of Things in real time. 5G will be the first generation of mobile communication systems that will enable the tactile Internet. The talk will advocate the need for the tactile Internet and describe the need for new technologies such as network coding and compressed sensing to break with the commonly accepted trade-offs between throughput, latency, resilience, and security. The talk will also highlight the change from purely centralized architectures to meshed solutions.

Biography: Frank H. P. Fitzek is a Professor and chair of the communication networks group at Technische Universität Dresden coordinating the 5G Lab Germany. He received his diploma (Dipl.-Ing.) degree in electrical engineering from the University of Technology – Rheinisch-Westfälische Technische Hochschule (RWTH) – Aachen, Germany, in 1997 and his Ph.D. (Dr.-Ing.) in Electrical Engineering from the Technical University Berlin, Germany in 2002 and became Adjunct Professor at the University of Ferrara, Italy in the same year. In 2003 he joined Aalborg University as Associate Professor and later became Professor. He co-founded several start-up companies starting with acticom GmbH in Berlin in 1999. He has visited various research institutes including Massachusetts Institute of Technology, MIT), VTT, and Arizona State University. In 2005 he won the YRP award for the work on MIMO MDC and received the Young Elite Researcher Award of Denmark. He was selected to receive the NOKIA Champion Award several times in a row from 2007 to 2011. In 2008 he was awarded the Nokia Achievement Award for his work on cooperative networks. In 2011 he received the SAPERE AUDE research grant from the Danish government and in 2012 he received the Vodafone Innovation price. In

2015 he was awarded the honorary degree “Doctor Honoris Causa” from Budapest University of Technology and Economy (BUTE). His current research interests are in the areas of wireless and mobile 5G communication networks, mobile phone programming, network coding, cross layer as well as energy efficient protocol design and cooperative networking.

Overview Talks

Using Games to solve Challenging Multimedia Problems

Oge Marques, Florida Atlantic University

Abstract: There are many challenging problems in multimedia research for which state-of-the-art solutions fall short of performing perfectly. The realization that many of these tasks are arduous for computers yet are relatively easy for humans has inspired many researchers to approach those problems from a human computation viewpoint, using methods that include crowdsourcing and games. The talk discusses how we can use human computation methods to supplement traditional content analysis techniques and assist in the solution of hard multimedia problems.

Bio: Oge Marques (http://faculty.eng.fau.edu/omarques/) is Professor of Computer and Electrical Engineering and Computer Science at Florida Atlantic University (FAU), Boca Raton (Florida). He has more than 25 years of teaching and research experience in the fields of image processing and computer vision. His research interests are in the area of intelligent processing of visual information, which combines the fields of image processing, computer vision, image retrieval, machine learning, serious games, and human visual perception. He is particularly interested in the combination of human computation and machine learning techniques to solve computer vision problems. He is the (co-) author of two patents, more than 100 refereed journal and conference papers, and several books in these topics, including the textbook Practical Image and Video Processing Using MATLAB, Wiley-IEEE Press (2011). He is Editor-in-Chief (with Borko Furht) of the upcoming 3rd edition of the Encyclopedia of Multimedia (http://encyclopediaofmultimedia.com). He is a senior member of both the ACM and the IEEE and a member of the honor societies of Tau Beta Pi, Sigma Xi, Phi Kappa Phi, and Upsilon Pi Epsilon.

More Juice Less Bits: MediaMelon Content Aware Streaming

Ali C. Begen, MediaMelon, Inc.

Abstract: Watching video over the Web is without a doubt the most popular way to access both free and premium content on connected devices for all kinds of consumers from novices to professionals. The underlying technology, called HTTP adaptive streaming, is quite straightforward; however, it does not always result in the most pleasant viewer experience due to quality fluctuations. This can cause dissatisfaction for consumers, leading to revenue loss for providers in both managed and unmanaged video services. In this talk, we will explain a new approach to adaptive streaming that we refer to as Content Aware Streaming. This is not just another adaptive streaming algorithm but a completely untraditional streaming toolset that enables premium viewer experience with minimal cost to the provider. After we briefly cover what solutions have been proposed for existing problems, and what worked and did not work for consumers and providers, we take a stab at clarifying some of the recent public announcements that have been largely misunderstood by the streaming community. Most

importantly, we explain why content-based encoding is not the solution by itself to the problems most providers are facing today.

Bio: Ali C. Begen has joined MediaMelon, Inc. as the principal architect for streaming technologies in February 2016, where he is currently heading the development efforts for MediaMelon's content-aware streaming solutions that enable premium viewer experience while minimizing operational costs and improving profitability. He has been a research and development engineer since 2001, and has broad experience in mathematical modeling, performance analysis, optimization, standards development and intellectual property innovation. Between 2007 and 2015, he was with the Video and Content Platforms Research and Advanced Development Group at Cisco, where he has architected, designed and developed algorithms, protocols, products and solutions in the service provider and enterprise video domains. Since 2007, he has been leading professional and academic projects, and teaching graduate-level courses and giving lectures in universities around the world.

Ali holds a Ph.D. degree in electrical and computer engineering from Georgia Tech. He received a number of scholar and industry awards, and he has editorial positions in prestigious magazines and journals in the field. He is a senior member of the IEEE and a senior member of the ACM. More recently, in January 2016, he was elected as a distinguished lecturer by the IEEE Communications Society. Further information on his projects, publications, keynotes, tutorials, and teaching, standards and professional activities can be found at http://ali.begen.net.

MPEG-DASH Spatial Relationship Description

Omar Aziz Niamut, Netherlands Organization for Applied Scientific Research(TNO)

Abstract: This talk presents the Spatial Representation Description (SRD) feature of the second amendment of MPEG DASH standard part 1, 23009-1:2014. SRD is an approach for streaming only spatial sub-parts of a video to display devices, in combination with the form of adaptive multi-rate streaming that is intrinsically supported by MPEG DASH. The SRD feature extends the Media Presentation Description (MPD) of MPEG DASH by describing spatial relationships between associated pieces of video content. This enables the DASH client to select and retrieve only those video streams at those resolutions that are relevant to the user experience. The paper describes the design principles behind SRD, the different possibilities it enables and examples of how SRD was used in different experiments on interactive streaming of ultra-high resolution video.

Bio: Omar Aziz Niamut is a senior research scientist at the Netherlands Organization for Applied Scientific Research (TNO), working on shared interactive and immersive media delivery. He received MSc. (2001) and PhD. (2006) degrees from Delft university of Technology. In 2007, he advised and reported to the European Parliament and the European Commission on the harmonisation of mobile TV. From 2008-2010, he made over 300 standardization contributions to ETSI TISPAN and advised the Singapore government on the use of IPTV standards. In 2007, he was the technical lead for one of the world's first user trial of social TV services and in 2014, he

led a joint effort with the BBC towards the world's first live tiled streaming of UHD video to end users. He has been active as work package lead in EU FP7 projects FascinatE, STEER and EXPERIMEDIA. He has presented at international industry events such as Broadband Home Forum, International Broadcast Convention, IPTV Seminar and IPTV World Forum, NEM Summit and Future Internet Assembly. He is an expert reviewer for the IWT funded iMinds ICON programme and a NEM ETP Steering Board member. He is author of multiple journal papers and conference publications in the fields of audio coding, interactive IPTV services and immersive media, filed 20 patent applications, contributed a chapter to a book on Social TV and co-edited a book on format-agnostic media. He has been serving as Co-chair and main organizer of the WSICC workshop 2013 and 2015, the workshop series (2013, 2014) on cross-breeding social networks and networked media in the Future Internet, and has been appointed as General Co-chair for ACM TVX 2017, the prime venue for publishing research related to TV and online video experiences.

Mulsemedia = multiple sensorial media = novelty or reinvention?

Gheorghita Ghinea, Brunel University, UK

Abstract: Traditionally, multimedia applications have primarily engaged two of the human senses? the audio and the visual? out of the five possible. With recent advances in computational technology, it is now possible to talk of applications that engage the other three senses, as well: tactile, olfaction, and gustatory. This integration leads to a paradigm shift away from the old multimedia towards the new mulsemedia : multiple sensorial media. In his talk, Dr. Ghinea is going to focus on the issue of the perceptual experience of mulsemedia and how research in the area has opened new and sometimes challenging opportunities for mulsemedia applications.

Bio: Dr. Gheorghita Ghinea is a Reader in the School of Information Systems and Computing at Brunel University, United Kingdom. He received the B.Sc. and B.Sc. (Hons) degrees in Computer Science and Mathematics, in 1993 and 1994, respectively, and the M.Sc. degree in Computer Science, in 1996, from the University of the Witwatersrand, Johannesburg, South Africa; he then received the Ph.D. degree in Computer Science from the University of Reading, United Kingdom, in 2000. His research activities lie at the confluence of Computer Science, Media and Psychology. In particular, his work focuses on the area of perceptual multimedia quality and building end-to-end communication systems incorporating user perceptual requirement. He has over 250 publications in leading international conferences and journals; Dr. Ghinea has co-edited two books on Digital Multimedia Perception and Design, and Multiple Sensorial Media Advance and Applications. He leads a team of 8 researchers and consults regularly to both public and private organisations and bodies in his areas of research expertise.

Smart Camera Systems

Bernhard Rinner, Alpen-Adria-Universität Klagenfurt

Abstract: Smart cameras combine video sensing, processing, and communication on a single embedded platform. Networks of smart cameras are real-time distributed embedded systems that perform computer vision using multiple cameras. This new approach has emerged thanks to a confluence of simultaneous advances in four key disciplines: computer vision, image sensors, embedded computing, and sensor networks. Recently these networks have gained a lot of interest in research and industry; applications include surveillance, assisted living and smart environments. In this talk I will introduce some fundamentals of the emerging field of smart camera systems, present selected examples and discuss trends and challenges for future systems.

Bio: Bernhard Rinner is professor at the Alpen-Adria-Universität Klagenfurt, Austria where he is heading the Pervasive Computing group. He is deputy head of the Institute of Networked and Embedded Systems and served as vice dean of the Faculty of Technical Sciences from 2008-2011. Before joining Klagenfurt, he was with Graz University of Technology and held research positions at the Department of Computer Sciences at the University of Texas at Austin in 1995 and 1998/99.

His current research interests include embedded computing, sensor networks and pervasive computing. Bernhard Rinner has been co-founder and general chair of the ACM/IEEE International Conference on Distributed Smart Cameras and has served as chief editor of a special issue on this topic in The Proceedings of the IEEE. Currently, he is Associate Editor for Ad Hoc Networks Journal and EURASIP Journal on Embedded Systems. Together with partners from four European universities, he has jointly initiated the Erasmus Mundus Joint Doctorate Program on Interactive and Cognitive Environments (ICE). He is member of IEEE and IFIP and member of the board of the Austrian Science Fund.

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